



2002 IN THE MOVES INSTITUTE

Michael Zyda, Director

SUMMARY

The MOVES Institute's mission is research, application, and education in the grand challenges of modeling, virtual environments, and simulation. Our specialties are 3D visual simulation, networked virtual environments, computer-generated autonomy, human-performance engineering, immersive technologies, defense and entertainment collaboration, and evolving operational modeling.

This has been a spectacular year in all specialties:

- In 3D visual simulation and networked virtual environments, we have created the extensible modeling and simulation framework (XMSF), in an effort that has been named the most important go-forward strategy for connecting all DoD modeling and simulation to C4I systems.
- Our terrorist behavior modeling effort, Project IAGO, has been listed as one of the top ten in the world in a DTRA survey of two hundred and sixty five existing terrorist behavior models.
- Our chromakeyed-augmented training environment will soon be deployed to helicopter squadron 10 (HS-10) to study its utility in flight navigation training.
- Our achievements in immersive technology have been outstanding. A patent for our inertial tracker is pending, and sounds we and LucasFilm's Skywalker Sound recorded, of an LCAC for a Marine Corps training VE, were employed industrially to accompany a hovercraft in the movie *Minority Report*.
- Our *America's Army* is the fastest-growing online game ever, with 1.4M registered players, and has won or been runner-up for several best-game-of-the-year awards. The game is considered a strategic communications tool similar to the Voice of America by the US Army, seen as having transformed Army recruiting by its accurate portrayal of the infantry career-path. The project is cited as a transformational model, not only turning the PC game into a communications medium, but demonstrating how innovative projects can be succeed within DoD. The Army believes *America's Army* will save some \$700M to \$4B per year during its period of operation. The game has been briefed to almost all three- and four stars in the US Army and the Secretary and Chief of Staff of the Army. Our project has inspired the CNO's Strategic Studies Group to study massively multi-player gaming for its potential in combat modeling; the Undersecretary of Defense and Joint Forces Command are pursuing similar studies. The game is the first successful effort in defense/entertainment collaboration, as spelled out in the National Research Council report, "Modeling and Simulation—Linking Entertainment and Defense."
- The Navy has assigned all future development of the Navy's Simulation System (NSS) to the MOVES Institute. Additionally, we led an effort to revise all combat modeling courses on campus.
- We have applied techniques from VE and the entertainment industry to improve and enhance humans' ability to comprehend complex tactical information in "live" command-and-control settings. We have shown that radio communications, radar, air traffic control tasks and possibly even UAV operations can be improved using spatialized auditory cues over headphones. Results will be summarized at the ForceNet 2003 conference in April.

With this much success, we are confident in what the next year will bring.

AN EDUCATIONAL MISSION

We support our students through courses and funded research directly related to our mission. Our projects provide readily available DoD- and DoN-relevant thesis topics for officer students. Funded projects indicate

serious interest in our research and educational abilities. In FY2002, MOVES had \$11.4M in reimbursable funding. Already in FY2003, we have some \$10M in reimbursables (forty-four accounts from thirteen sponsors).

Over the past year, MOVES has secured international recognition in research, development and education. We have expanded greatly, as suggested by payroll: in March 2002, we employed fifty faculty and staff; in March 2003, seventy-six. The number of students involved in institute projects increased from forty to sixty-eight. They hail from twelve different curricula (MOVES, CS, OR, IT, IS, NSA, IW, meteorology, ME, ECE, UW and C4I). Twenty theses were completed, as posted on our Website.

3D VISUAL SIMULATION

Technical Director – Dr. Don Brutzman

Extensible 3D (X3D) Graphics

NPS has been instrumental in standardizing the extensible 3D (X3D) graphics specification, collaborating with the Web3D Consortium, International Standards Organization, and World Wide Web Consortium to produce a synthesis of the Virtual Reality Modeling Language (VRML) and the Extensible Markup Language (XML) that enables X3D graphics to be used for Web-based viewing of 3D scenes. The addition of geospatial representations, humanoid animation, distributed-interactive-simulation (DIS) networking capabilities, advanced 3D rendering, computer-aided design interchange, and other capabilities is finally making 3D graphics and visualization broadly available on the Web.

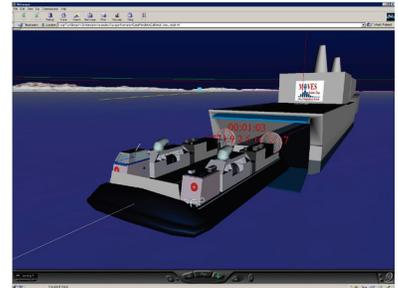
Scenario Authoring and Visualization for Advanced Graphics Environments (SAVAGE)

For several years we have built sophisticated open-license military models in X3D as part of the SAVAGE project. Dozens of students have contributed high-resolution models for ships, aircraft, submarines, land vehicles, robots, humanoid behaviors, environmental effects, etc. The SAVAGE archive is a multiple-CD set documenting over 700 military models, scenarios, theses, etc. Some images from the archive are above.

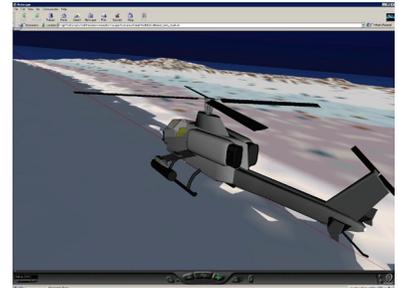
Autonomous Underwater Vehicle Visualization

NPS provides sophisticated capabilities in modeling and visualizing oceanographic data collected by underwater robots. With Office of Naval Research (ONR) sponsorship,

Air-cushioned landing craft (LCAC) docks with an amphibious assault ship as part of a Camp Pendleton scenario.



Cobra helicopters fly combat air patrol, again in amphibious-raid scenario.

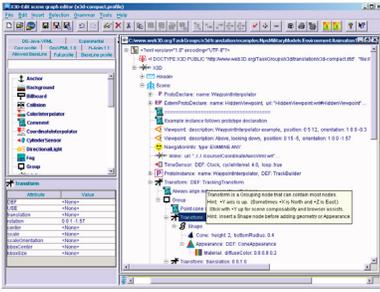


MV Ehime Maru is shown as part of reenactment of collision with USS Greenville

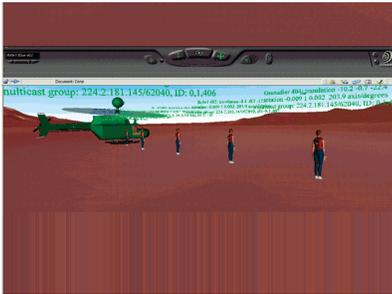


we have participated in fleet battle experiments not only to assess minefield-clearance effectiveness by various robots, but also to translate telemetry and communicate naval messages to the global Command-and Control System (Maritime) mine-warfare environmental-database- analysis library.

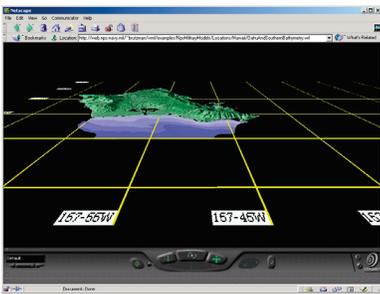
Use of XML for operations orders has enabled us to autogenerate large-scale virtual environments corresponding to regional (and potentially theatrical) operations. This significant new capability can be communicated via existing message circuits, but has not yet been deployed to operating forces because differences in terminology among the warfighting community



Context-aware X3D-Edit authoring tool provides automatic validation of new 3D scenes.



Team of networked humanoid avatars embark on helicopter and debark in remote location, demonstrating IEEE DIS protocol behavior.



3D model of Oahu generated from terrain database is augmented by latitude, longitude visual aids

A common vocabulary with common semantics (i.e. a tactical ontology) is needed; NATO's battlespace generic hub (BGH) appears a good candidate for such a model. Supervised by the secretary of defense's Advanced Concepts Technical Demonstration office, and in partnership with the Naval Undersea Warfare Center and Institute for Defense Analysis, we are showing how BGH can be expressed in XML for modeling joint and coalition tactical scenarios. This work is seen as necessary for enabling worldwide battlespace presence, monitoring, and visualization. Applications to homeland defense and assessment of the effects of weapons of mass destruction provide further challenges.

Networked Virtual Environments: Extensible Modeling & Simulation Framework (XMSF)

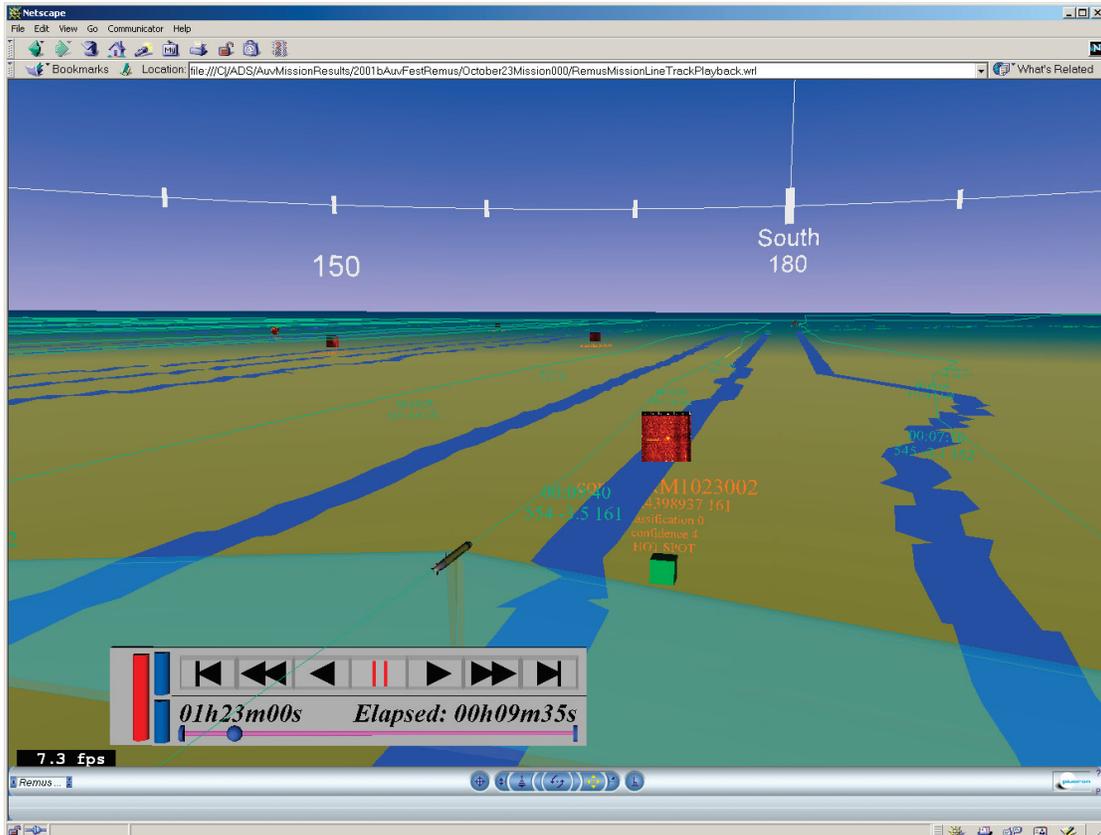
As DoD engages in warfighting and institutional transformation for the new millennium, DoD modeling and simulation (M&S) must identify and adopt transformational technologies of direct tactical relevance to warfighters. The only software systems that composably scale to worldwide scope utilize Web technologies; it is therefore evident that an extensible Web-based framework offers great promise to scale up the capabilities of M&S systems to meet the needs of training, analysis, acquisition, and operational warfighters. By embracing commercial Web technologies as a shared-communications platform and ubiquitous-delivery framework, DoD M&S can fully leverage mainstream practices for enterprise-wide software development.

To meet these transformational challenges for M&S, we are defining an extensible modeling and simulation framework (XMSF) that can exploit Web-based technologies. An exceptional group of government, academic, and industry experts are working together under the leadership of investigators from the Naval Postgraduate School, George Mason University, SAIC and Old Dominion University. XMSF is defined as a composable set of standards, profiles and recommended practices for Web-based modeling and simulation. XML-based markup languages, Internet technologies, and Web services will enable a new generation of distributed M&S applications to emerge, develop and interoperate.

XMSF integrates several high-level requirements derived from years of experience with M&S frameworks and the problems of their effective deployment across diverse networks and systems. XMSF must enable simulations to interact directly and scalably over a highly distributed network, achieved through compatibility between a Web framework and networking technologies, and be equally usable by human and software agents. Clearly, XMSF must support composable, reusable model components. Its use must not be constrained by proprietary technology or legally encumbered patents, since such barriers discourage free, open, *ad hoc* development.

The precepts of XMSF are:

- Web-based technologies applied within an extensible framework will enable a new generation of M&S applications to emerge, develop and interoperate.



DVD interface controls playback of Woods Hole Oceanographic Institute underwater robot REMUS to assess sidescan sonar detection of mine-like objects and bathymetry during fleet-battle experiment

- Support for operational tactical systems is a missing requirement for such M&S applications frameworks.
- An extensible framework of XML-based languages can bridge forthcoming M&S requirements and open/commercial Web standards, while supporting existing M&S technologies.
- Compatible, complementary technical approaches are now possible for model definition, simulation execution, network-based education, network scalability, and 2D/3D graphics views.
- Web approaches for technology, software tools, content production and broad use provide best business cases from an enterprise-wide (worldwide) perspective.

NETWORKED VIRTUAL ENVIRONMENTS Technical Director: Dr. Don Brutzman

MOVES continues research in networked virtual environments through NPSNET-V, a platform for investigating new concepts in related design. It features composable components, and can be extended at runtime; it is graphics-standard agnostic, and can use entirely new network protocols loaded at runtime. It has been used to test new ideas in interest management, security, and dynamic extensibility.

Cross-format schema protocol (XSFP) is a technique for saving XML data in binary format. XML data is useful because it can be read by many platforms. However, it is verbose, storing all data in string format. XSFP is a way to use XML in bandwidth- or storage-constrained environments and increase processing speed in data-intensive XML documents.

MOVES continues to develop DIS libraries in many contexts, including Java, X3D, and browser plugins, and is describing DIS protocol in terms of XML and XSFP.

COMPUTER GENERATED AUTONOMY

Technical Director: John Hiles

In 2002, the MOVES Institute established the Center for the Study of Potential Outcomes to focus on using our connector-based, multi-agent systems (CMAS) concept and cognitive science to model terrorist behaviors. The first project of that center is Project IAGO.

Project IAGO (integrated, asymmetric, goal organization) is an effort to develop a conceptual model and prototype implementation of a cognitive model of the decision-making and dynamic behaviors of terrorists. The ultimate object is to develop a tool for intelligence analysts in the war on terrorism, enabling them to explore a complex, hyper-dimensional space of terrorist capabilities and possibilities in a social space, with potential for identifying infrastructure vulnerabilities as well as detection/prevention opportunities. This work also explores potential benefits and limitations of application of the CMAS concept, a modeling approach conceived by MOVES professor John Hiles. The CMAS approach is inspired by the enormously successful information exchange and -processing techniques that have evolved at the cellular level.

The initial IAGO effort intends to break ground in the construction of a prototype cognitive model for exploring terrorist behaviors. The work is separated into complementary phases:

- Phase 1: Demonstration Model. Initial design and implementation work to generate software components that capture fundamental CMAS concepts of tickets, connectors, and templates. Lessons learned from this effort provided the software foundation for phase-two activities.
- Phase 2: Proof-of-Concept Model. This phase produced an initial prototype implementation of mental blending, a cognitive-psychological model of creative thought, in which perceptions and concepts are combined under the guidance of generic

problem-solving mental spaces and goal motivations to create cognitive blends (see the discussion of cognitive training agents below). Development of the proof-of-concept model is continuing in order to yield more complex blended spaces from the initial mechanisms.

- Phase 3: Domain Demonstration. The next phase in Project IAGO development is application and demonstration of the blended-mental-space modeling approach to represent influences and dynamics in forming terrorist behaviors leading to decisions and actions. The intent is to show the potential of the modeling approach as a foundation for future enhancement, to produce a model that will be useful to the analytical community. Early work with anti-terrorism domain experts has resulted in a characterization of decision elements influencing terrorist behaviors. This information provides the basis for formulation of initial subject generic spaces and goals for interplay with a stream of information to produce behaviors that can be compared with real-world actions.

While our funding for IAGO has been small in FY2002, the project shows great promise. In 2002, the Defense Threat Reduction Agency contracted with the MIIS Center for Nonproliferation Studies for a literature review of existing terrorist-behavior models. Two-hundred-and-sixty-five models were studied by CNS, and the MOVES Institute's IAGO model is listed as one of the top ten worldwide, though still under development.

Cognitive Training Agents

In January 2003, the MOVES computer-generated autonomy team reached a milestone. Using a multi-agent system combined with CMAS technology we developed over the last three years, we demonstrated that our software could do what cognitive psychologists call *cognitive blending*, producing *cognitive-integration networks*. That is, our software was able to create new knowledge *in situ* based on what it was doing and what it wanted to accomplish. Until this time, advanced multi-agent work has only been able to demonstrate the ability to adaptively explore problems with intent and purpose. Software blending means that multi-agent software can now be built to answer questions such as, "What do you

know?” “How do you know that?” or (most importantly for training), “What are you doing?”

In the next year, we intend to extend these experimental results to create adjustable cognitive training agents that will add new capabilities to training. The cognition of these agents will be built-in and applicable to a range of applications. Specialization will take place outside these capabilities (for example, a specific application will require specific input and output routines (sometimes referred to as input and actuator suites), and an application-specific set of meta-data packages that we call generic spaces, which would describe the types of cognitive operations needed in that particular subject area).

Training software equipped with cognitive-training agents could ultimately take on the following capabilities:

- Training that involved competition with virtual opponents would add the dimension of adversaries that adapt, deceive, and could explain what they were doing and why.
- Training for tasks that do not involve problem solving could self-adjust to press students to the limits of their understanding and then offer explanations of those boundaries and what additional work could expand them, if that were possible. In this and the following types of training applications, the cognitive training agents would guide the training software rather than act as adversary.
- Training for problem-solving tasks in areas that demanded innovation and discovery could continuously alter the problem environment to keep it open and freshly challenging.

Not all (or even most) training software would benefit from these properties. But important new training benefits can be built on the foundation of software that adapts and incorporates discoveries into knowledge that it produces as it goes.

HUMAN-PERFORMANCE ENGINEERING

Technical Director: Dr. Rudy Darken

We believe that there are two fundamental barriers to achieving the transformation in training the CNO has called for (1) driving down the cost of simulation for

training, and (2) shortening the development cycle from mission-need to product. Low-cost simulators and the ability to bring training to the fleet at a much accelerated pace will have an immediate impact on the individual warfighter. HPE has been focusing on these issues through the VIRTE program to develop high-fidelity deployable trainers.

So far, our work has included the development of a Chromakey-augmented training environment whereby the near-field cockpit of a helicopter is captured with a camera and mixed with a simulated “out the window” view, allowing inexpensive reconfigurable training to occur. Similarly, we are developing a “suitcase” simulator for close-quarters battle for the second phase of VIRTE, miniaturizing as many components as possible to facilitate shipboard usage. This will be integrated with our forward-observer trainer towards a full spectrum combined-arms training capability. A common theme in our approach is the use of open standards and computer gaming technologies to increase performance while driving down development costs. All simulations for training developed in our laboratory undergo thorough testing both in house and in the fleet to determine their value in transfer of training.

As a part of DARPA’s augmented-cognition (Aug-Cog) program, MOVES is researching a context machine to “improve the performance of the human-machine symbiosis by an order of magnitude or greater,” thereby contributing to Aug-Cog’s goal of improving warrior/computer interactions, advancing systems-design methodologies, and re-engineering military decision-making at a fundamental level. MOVES is exploring the computer science behind creating a system able to determine a situation’s context and thereby assist in accomplishing its goals. Using a game engine to simulate real-world inputs and provide a means of output, MOVES has built a prototype system and continues research into the artificial intelligence and other factors required to determine context and act upon it.

In addition, MOVES has evaluated the training effectiveness of a damage-control trainer built at University of Illinois, Urbana-Champaign. We evaluated the system on surface-warfare officers stationed at NPS to understand the efficacy of the system in training DCAs. We expect to present our findings at ONR Workshop in

May. Funding for HPE has been provided by ONR, N61M, DARPA, and the FAA.

IMMERSIVE TECHNOLOGIES

Technical Director: LCDR Russell Shilling, USN

The Immersive Technologies Directorate met major milestones in several areas during the past year. The goal has been not only to apply virtual environment and video-game technology to training tasks, but also bridge the gap between these technologies and the operational- warfare environment.

First, technologies were advanced for the development of a sourceless postural tracking system using magnetic and inertial sensors to accomplish full-body tracking in a virtual environment. The unique and exciting part of this technological advance centers on a tracking device only slightly larger than a quarter. Patents for this device should be forthcoming.

Immersive Technologies also examined the use of positional sound to enhance both virtual environments and advanced display technology that can be incorporated into future network-centric-warfare applications. Four thesis projects examined the use of spatial-audio technology over headphones to improve radio communications and situational awareness of local airfield controllers and to further sonification research for the Marine Corps's Project Albert, as well as to enhance multi-user virtual environments.

These same technologies can also be applied to radar, sonar, and UAV operations and have been shown to enhance the reaction time of pilots responding to incoming missile threats. These technologies are being combined with a tactile sensor vest developed at NAMRL in Pensacola under an international research project with

the Czech Republic and Bulgaria. The goal will be to enhance the situational awareness of pilots in actual tactical environments using virtual technologies.

Our research into information-fusing enhancement uses auditory displays and video-game interfaces to improve human performance and cognitive abilities. The project applies spatial-auditory display technology and ideas used in the entertainment industry to command and control tasks such as radio communications, surface-to-air missile displays, radar, sonar, ATC and UAV operations.

Spatial-auditory displays allow audio cues to be presented with a complete sensation of elevation and azimuth over a standard set of stereo headphones. With this capability, we can create auditory icons that appear to emanate from the direction of the object they represent; for example, an incoming-missile alert would be sent from the direction of the actual missile. Our lab has found that a radar display so equipped can shave 350 msec or more off a pilot's reaction time; used for radio communications, the display improves information recognition dramatically.

In other work, we are considering the application of visual interfaces used in video-game technology to identify ways of representing multi-dimensional information that might be applied to operational, real-time display of tactical data. Video games use a number of techniques to help a novice gamer become "situationally aware" quickly within a very complex, multi-user

game space. These same techniques might be applicable to Navy command and control operations.

Recordings were completed for an LCAC simulator under development for the Marine Corps's VIRTE program, in cooperation with Lucasfilm's Skywalker Sound Division. At no cost to the government, Skywalker Sound helped us record the LCAC and professionally edited the recordings. In return, they used the recordings in the



A Chromakey-augmented training environment

critically acclaimed Stephen Spielberg movie, *Minority Report*, now nominated for an Academy Award for sound editing. We continued extensive collaborations with other entertainment giants such as Dolby, Creative Labs, and THX. Four other theses were completed using technology associated with *America's Army: Operations* and the Marine Corps's VIRTE program, which looked at audio requirements for modeling MOUT tasks in VEs, and measured the physiological impact of VE technology and emotion/arousal on cognitive abilities in a training task.

Finally, using the student-built cave system and other visual technologies, we are combining entertainment techniques, video-game technology, and advanced display design to solve problems associated with information management in network-centric warfare tasks, especially in command and control (video games routinely use various strategies to allow players to track and manipulate hyper-dimensional data within game play).

We will see if some of these same strategies can be applied to helping planners, analysts, and operators track multi-dimensional data sets associated with the fusion of large amounts of tactical data from different sources in a live warfare setting. At the same time, we will be examining game engines and editors to see if traditional methods of war gaming might be better implemented or improved using game-engine technology. Results of this research will be presented at ForceNet in April 2003.

EVOLVING OPERATIONAL MODELING

Technical Director: LCDR Alex Callahan, USN (ret)

The technical directorate for evolving operational modeling became established as the configuration manager for the naval simulation system (NSS), an analytical model with unique capabilities for representing network-centric warfare.

The directorate coordinated efforts between SPAWAR Systems Center, San Diego, developers and testing agencies to ensure the quality of delivered versions, and continued to nurture a broad base for operational analysis across government, military, and commercial interests, with NSS as the focal point.

Evolving Operational Modeling obtained tasking in several key areas of NSS employment, including analysis

of alternative platforms for the multi-mission aircraft program. The directorate prepared draft curriculum materials for a new course, applied combat modeling, providing insights into the application of combat models (using NSS as the exemplar) to military operational analysis.

The directorate led a working group of faculty from operations research and MOVES to review the combat modeling curriculum at NPS. As a result of these efforts, existing combat modeling courses have been revised, greater infrastructure has been provided for the wargaming analysis course, and a school-wide wargaming policy and advisory committee has been established to revitalize application of warfare gaming across multiple disciplines.

DEFENSE/ENTERTAINMENT COLLABORATION

Creative Director: Alex Mayberry

The MOVES Institute has been in the press continually over the last year with our *America's Army* project (see Appearances, below). *Newsweek* has toasted "the legendary Naval Postgraduate School" in the aftermath of *America's Army: Operations* and its success, and we will soon be in *Newsweek* again.

The *America's Army* project is a success on many fronts. It has engendered much faculty and thesis-student interaction, yielding several completed theses this year, and has brought NPS much positive media attention. It has inspired the CNO to task the Naval War College's strategic studies group (SSG) to perform a study on the utility of massively multi-player gaming as the basis for the development of future large-scale M&S systems. That study reports out to the CNO in July 2003. The MOVES director gave a presentation on the project to the SSG in December 2002 for that study. The last two SSG plenary meetings have discussed massively multi-player gaming.

America's Army is highly approved by the sponsor for its transformation of Army recruiting. As of the 25th of February 2003, there were 1.4M+ registered players of *America's Army*, with 900K+ having completed basic combat training in the game. Over 81M+ game missions have been completed, and some 60K gaming hours per day are played.

To understand the dividends of the game from the US Army perspective, a look at traditional recruiting is in order.

The army spends \$2B (two billion) per year to attract and enlist 120,000 recruits (80,000 army, 40,000 national guard). That's \$16,666 per soldier.

Twenty percent (or 24,000) of these recruits drop out during basic combat training with the excuse that the army was not what they expected and combat training was not for them. With them goes \$400M in wasted recruiting expenditure. In addition, the army has spent \$75K each for training; thus, the army's loss per annum from this drop-out group is \$2.2 billion.

America's Army cost \$7M to build over the first twenty-four months, a tag equivalent to that of 420 recruits who wash out (if we count recruiting costs alone). If the game encourages only 120 potential waverers to stick with it, it's broken even, counting recruiting and training costs. And of course, if it attracts those who would not otherwise have considered an army career, it's worth \$92K apiece.

The Army estimates *America's Army* has the potential to save some \$700M-\$4B per year. With respect to recruitment, actual results won't be known for four or five years, when the current raft of thirteen- and fourteen-year olds will be old enough to join. The hope is that through realistic role playing and exploration of a soldier's job, the important work of the military will be among the options that compatible young men and women will consider when planning a career.

By August 2003, occupations within the game will include infantry, medic, engineers, RSTA/Scouts, and special forces:

- Medic/91W & combat lifesaver: Four missions, from AIT at Brooke Army Medical Center through an STX under field conditions. These missions will be pass-fail and enact expert information on combat lifesaving. This training will also convey lifesaving information applicable to the general population for homeland defense. One mission will incorporate training to recognize the symptoms of nerve agent as well as immediate self- and buddy-aid for nerve-agent casualties (funded by FORSCOM).

- Special Forces: Several missions to replicate the Robin Sage exercise as part of SFAS with emphasis on land navigation and escape and evasion. These mission will qualify players to enter specialized S.F. training and be assigned in multiplayer S.F. missions.

New units and weapons to be added into *America's Army*:

- Stryker: the Stryker will debut in May in a transport- and support-by-fire role within a new online, multiplayer mission. Coverage of the SBCT within the Game will expand throughout the summer of 2003.
- TACOM-ARDEC is funding incorporation of the objective individual combat weapon (OICW) and the shoulder-launched multipurpose assault weapon/ bunker-defeat munition (SMAW-D) into the game.

Defense/Entertainment Spin-offs from the *America's Army* Project

Having a successful online game inside the MOVES Institute is like having your own particle accelerator. Lots of proposed applications and interesting research are coming in the door.

Many related training applications using the *America's Army* code base as a starting point are being considered. We have funding from one project that's using *Operations* for treaty verification pre-planning, and an Air Force group is looking at funding a training level within the game that will deal with force protection.

Infantry soldiers at Fort Benning are using *Operations* before setting foot on the real range. Also, the Army's objective force is having us integrate prototypes of their new weapons systems into *Operations* to evaluate their potential utility. We are building special levels of the game for the special forces, both for recruiting and SF training.

We have strong interest from Commander Naval Surface Forces Pacific in our building a game for material-assessment training. They have approved both proposal and schedule and are raising funding for the project. One extraordinary possibility, raised by the undersecretary of defense's office, is massively multiplayer (MMP) gaming.

The *America's Army* project is being looked at both as a model of how such an effort could be carried out within government and as possible starting point for a MMP project. The work involved might include the procurement (or development) of a government-owned game engine capable of full-spectrum combat modeling and large-scale inter-operability integration, as well as a programming interface for modeling individual and organizational behaviors and stories.



America's Army: Operations *field maneuvers*

An additional goal would be a rapid prototyping interface to the MMP that would allow any mission to be put together nearly overnight.

NAVY BOARD ANNUAL PROJECTS

In February 2002, VADM Richard Mayo, USN sent a memo to the NPS superintendent listing N61M projects in support of Navy modeling and simulation efforts. That memo indicated strong support for projects specified in our annual umbrella proposal entitled "The MOVES Institute FY02." We are continuing much of that work in the MOVES Institute FY03 umbrella proposal, also funded by N61M. VADM Mayo indicated that proposed projects in agent-based simulation and computer-generated autonomy were crucial to network-centric warfare and programs such as FORCENET. In addition to support of our annual research base submission, VADM Mayo indicated *very strong support* for our Center for the Study of Potential Outcomes and blessed Project IAGO of that center as our annual project.

CONCLUSION

This has been a spectacular year for the MOVES Institute. We have spent considerable time building our reputation outside NPS in the DoD and the Navy. We are known outside of NPS as *the lead technical and educational organization* in defense modeling, virtual environments, and simulation. Our largest issue is growth space to accommodate the new projects from our success.

SPONSORS

ARO
N61M
DARPA
NAVAIR
DMSO
NSF
DTRA
OASA
FAA

ONR

FORSCOM
TRADOC Analysis Center
Los Alamos National Labs

THESES AND DISSERTATIONS

Arisut, LTJG Omer, Turkish Navy. "Effects of Navigation Aids on Human Error in a Complex Navigation Task." MS in MOVES, March 2002.

Aronson, MAJ Warren., USA "A Cognitive Task Analysis for Close Quarters Battle." MS in computer science in cooperation with MOVES, September 2002.

Back, LT David, USN. "Agent-Based Soldier Behavior in Dynamic 3D Virtual Environments," MS in MOVES, March 2002.

Brannon, LTCOL David, USMC and Villandre, MAJ Michael, USMC. "The Forward Observer Personal Computer Simulator (FOPCSIM)." MS in computer science in cooperation with MOVES, September 2002.

Calfee, LT Sharif, USN. "Autonomous Agent-Based Simulation of an AEGIS Cruiser Combat Information Center Performing Battle Group Air Defense Commander Operations," MS in MOVES, March 2003.

Campbell, LT James, USN. "The Effect Of Sound Spatialization on Responses to Overlapping Messages," MS in operations research in cooperation with MOVES, June 2002.

Desypris, LT Georgios, Hellenic Navy. "Enhancement Of Learning Process In Web-based Courses Using Combined Media Components," MS in computer science in cooperation with MOVES, September 2002.



America's Army: Ft. Benning rifle range

Dickie, CAPT Alistair, Australian Army. "Modeling Robot Swarms Using Agent-based Simulation," MS in operations research in cooperation with MOVES, June 2002.

Greenwald, MAJ Thomas W., USA. "An Analysis Of Auditory Cues For Inclusion in a Virtual Close-Quarters Combat-Room Clearing Operation," MS in MOVES, September 2002.

Harney, LT James W., USN. "Analyzing Tactical Effectiveness for Anti-Terrorist Force Protection (AT/FP) Using X3D Graphics and Agent-Based Simulation," MS in MOVES, March 2003.

Krebs, CDR Eric M., USNR. "An Audio Architecture Integrating Sound And Live Voice for Virtual Environments," MS in MOVES, September 2002.

Lennerton, MAJ Mark, USMC. "Exploring A Chromakeyed Augmented Virtual Environment As An Embedded Training System For Military Helicopters," MS in computer science in cooperation with MOVES, March 2002.

List, MAJ Robert, USMC. "A Rendering System Independent High-Level Architecture Implementation for Networked Virtual Environments," MS in computer science in cooperation with MOVES, September 2002.

Michael, LT Robert, USN and Staples, LT Zachary, USN. "Targeting Networks: Stimulating Complex Adaptive Systems for Accelerated Learning and Organizational Impotence," MS in MOVES, March 2003.

Mowery, MAJ Samuel, USMC. "Enhancing the Situational Awareness of Airfield Local Controllers," MS operations research in cooperation with MOVES, 2002.

Orichel, CAPT Thomas, German Army. "Adaptive Rules In Emergent Logistics (ARIEL)," MS in MOVES, March 2003.

Osborn, CDR Brian, USN. Dissertation, "An Agent-based Architecture For Generating Interactive Stories," Ph.D. in computer science in cooperation with MOVES, September 2002.

Peitso, LCDR Loren, USN. "Visual Field Requirements for Precision Nap-of-the-Earth Helicopter Flight," MS in MOVES, September, 2002.

Perkins, MAJ Keith M., USA. "Implementing Realistic Helicopter Physics in 3D Game Environments," MS in MOVES, September 2002.

Reece, CAPT Jordan, USMC. "Virtual Close Quarters Battle (CQB) Graphical Decision Trainer," MS in computer science in cooperation with MOVES, September, 2002.

Sanders, MAJ Richard, USA, and Scorgie, LT Mark, USN. "The Effect of Sound Delivery Methods On A User's Sense of Presence in a Virtual Environment," MS in MOVES, March 2002.

Spears, LT Victor, USN. "Terrain Level of Detail in First-person, Ground-perspective Simulation," MS in MOVES, March 2002.

Thien, CAPT Robert, USMC. "Realistic Airspace Simulation through the Use of Visual and Aural Cues," MS in computer science in cooperation with MOVES, June 2002.

Ulate, LT Stephen O., USN. "The Impact of Emotional Arousal on Learning in Virtual Environments," MS in MOVES, September 2002.

VanPutte, MAJ Michael, USA. "A Computational Model and Multi-agent Simulation for Information Assurance," Ph.D. in computer science in cooperation with MOVES, June 2002.

Wu, LT Hsin-Fu, USN. "Spectral Analysis and Sonification of Simulation Data Generated in a Frequency Domain Experiment," MS in operations research in cooperation with MOVES, 2002.

PUBLICATIONS

Conferences: Accepted Papers/Published Papers

Andrade, S., Rowe, N., Gaver, D., and Jacobs, P. "Analysis of Shipboard Firefighting-team Efficiency Using Intelligent-agent Simulation," *Proceedings of the 2002 Command and Control Research and Technology Symposium*, Naval Postgraduate School, Monterey, CA, June 11-13, 2002.

Barkdoll, T. C., Gaver, D. P., Glazebrook, K. D., Jacobs, P. A., and Posadas, S. "Suppression of Enemy Air Defenses (SEAD) as an Information Duel," *Naval Research Logistics* 49 : 723-742, 2002.

Blais, C.L., Brutzman, D., Harney, J.W., & Weekley, J. "Emerging Web-Based 3D Graphics for Education and Experimentation," *Proceedings*, Interservice/Industry Training, Simulation, and Education Conference, Orlando, December 2002. Nominated, best paper, ITSEC.

Blais, C., Brutzman, D., Harney, Weekley, J. "Web-based 3D reconstruction of scenarios for limited objective experiments," *Proceedings*, Summer Computer Simulation Conference, San Diego, July 2002.

Brutzman, D., Zyda, M., Pullen, M., Morse, K. "Extensible Modeling and Simulation Framework (XMSF) Challenges for Web-Based Modeling and Simulation," findings and recommendations report, Technical Challenges Workshop, Strategic Opportunities Symposium, Monterey, October 2002.

Gaver, D. P., and Jacobs, P. A. "Battlespace/Information War (BAT/IW): a System-of-Systems Model of a Strike Operation," Naval Postgraduate School Technical Report, NPS-OR-02-005, August 2002.

Shilling, R., Zyda, M., Wardynski, C. "Introducing Emotion into Military Simulation and Videogame Design: *America's Army: Operations* and VIRTE," "in *Proceedings of the GameOn Conference*, London, 30 November 2002.

Shilling, R.D. "Contribution of Professional Sound Design Techniques to Performance and Presence in Virtual Environments: Objective Measures." *Proceedings of 47th Department of Defense Human Factors Engineering Technical Advisory Group Meeting*, September 2002, San Diego, CA.

Shilling, R.D. "Enhancing Performance in Tactical Environments Using Immersive Auditory Displays and Data Sonification Techniques." ONR Cognitive Sciences Workshop, George Mason University, 2002.

Shilling, R.D. "Entertainment Industry Sound Design Techniques to Improve Presence and Training Performance in VE," European Simulation Interoperability Workshop, London, England, 2002.

Shilling, R.D., Zyda, M. & Wardynski, E. "Introducing Emotion into Military Simulation and Videogame Design: *America's Army: Operations* and VIRTE," European Simulation Office, Game-On 2002, London, England, 2002.

Trefftz, H., Marsic, I., and Zyda, M. "Handling Heterogeneity in Networked Virtual Environments," *Proceedings of IEEE VR*, Orlando, Florida, 25 - 27 March 2002

Trefftz, H., Marsic, I., and Zyda, M. "Handling Heterogeneity in Networked Virtual Environments," *Presence*, Vol. 12, No. 1, February 2003: 38-52, (revised from IEEE VR 2002 paper).

VanPutte, M., Osborn, B. and Hiles, J. "A Composite Agent Architecture for Multi-Agent Simulations," 11th Computer Generated Forces and Behavioral Representation Conference, Orlando, Florida, 7 - 9 May 2002.

Invited Papers

Stanney, K. M. and Zyda, M. "Virtual Environments in the 21st Century," in *Handbook of Virtual Environments—*

Design, Implementation, and Applications, Lawrence Erlbaum Associates, Publishers, Mahwah, NJ, 2002.

Zyda, M., Mayberry, A., Wardynski, C., Shilling, R., Davis, M. "The MOVES Institute's *America's Army: Operations Game*," Proceedings of *ACM SIGGRAPH 2003 Symposium on Interactive 3D Graphics*, 28-30 April 2003: 217-218, color plate p. 252.

Zyda, M., and Bennett, D. "The Last Teacher," in *2020 Visions*, from the Summit and Press Conference on the Use of Advanced Technologies in Education and Training, US Department of Commerce, 17 and 27 September 2002.

Zyda, M., Hiles, J., Mayberry, A., Wardynski, C., Capps, M., Osborn, B., Shilling, R., Robaszewski, M., Davis, M. "Entertainment R&D for Defense," *IEEE Computer Graphics and Applications*, January/February 2003.

Books, Chapters

Cockayne, W. & Darken, R.P. (in press). "The Application of Human Ability Requirements to Virtual Environment Interface Design and Evaluation." *Handbook of Task Analysis for Human-Computer Interaction*. Diaper, D. & Stanton, N. Eds.

Shilling, R.D., Shinn-Cunningham, B. "Virtual Auditory Displays." *Virtual Environments Handbook*, Kaye Stanney, New York, Erlbaum, 2003.

Appearances/Participation in/on Videotape, Live Demonstrations, and Press

Lenoir, Tim. "Fashioning the Military-Entertainment Complex," in *Correspondence, an International Review of Culture & Society*, Publisher: Council on Foreign Relations, Issue No. 10, Winter 2002-2003.

17 September and 27 September 2002: Summit & Press Conference on the Use of Advanced Technologies in Education and Training, US Department of Commerce, "2020 Visions."

20 August 2002: *Monterey County Herald*, "Navy School Computer Program is Virtual Hit," by Kevin Howe.

16 April 2002: ABC 7 News, KGO, "Hope Against Terrorism," Katarina Rusk.

E3 coverage of the announcement of *America's Army* 21 May 2002

Kuroshin, "America's Army: The Game," by AmberEyes. *USA Today*, "Army gives new meaning to war games—on a PC," by Marc Saltzman.

22 May 2002

US Army official press release.

La Times front page on opening day of E3 (only E3 Story printed), "Army's New Message to Young Recruits: Uncle Sim Wants You," by Alex Pham.

LA Times movie clip from Web site, with Alex Pham.

Army Link News, "Army Game to Debut This Summer," by Heike Hasenauer.

BusinessWeek Online, "The Army's New Killer App," by Arlene Weintraub.

Chicago Tribune, "Army to Recruits: Uncle Sim Wants You," by Alex Pham.

CNET, "US Army Invades Game Business," by David Becker.

CNN.COM, "Army is Looking for a Few Good Gamers," by Renay San Miguel.

MSNBC.COM, "Video Game Used To Recruit for Armed Forces."

PC Magazine, "US Army Develops Free Combat Simulation," by Mark Hachman.

23 May 2002

AP photo of *America's Army* booth at E3.

BBC News, "US military reveals computer game."

Detroit Free Press, "Game Master: Army Game to Draft Virtual Soldiers," by Jim Schaefer.

GameSpot, "E3 2002: *America's Army* Impressions."

LANParty.com, "*America's Army: Operations*," by Phineas.

Mercury News, "US Army Invades Video Game Territory," by Anthony Breznican.

New York Times, "Army Recruiting Through Video Games."

CNET Japan, "America's Army."

PC Web, Japan.

Reuters, "Army Turns to Computer Games to Woo Recruits," by Franklin Paul.

Slashdot Reaction to the E3 Announcement.

Washington Post, "A Chance to Be All You Can Be—in a Virtual Army," by Jeff Adler.

WFMY news broadcast

Wall Street Journal, "Videogame Players to Get Look at Life in the US Army," by Patrick Maio.

Yahoo News, photos 1 and 2.

24 May 2002

Fortune, blog in “Peter Lewis On Technology.”

Frictionless Insight, “Frictionless Insight’s First Annual E3 Awards,” by Kyle Ackerman and Rob de los Reyes. Best Business Model awarded to *America’s Army*.

InformationWeek.com, “An Army of One Online,” by Tischelle George.

Taipei Times, “Video-gamers Be All They Can Be.”

25 - 31 May 2002

25 May: UCLA *Daily Bruin*, “Army Targets, Misleads US Youth,” by Shirin Vossoughi.

27 May: Frictionless Insight, “*America’s Army*, the Official US Army Game,” Kyle Ackerman

27 & 28 May: User Friendly comic.

29 May: *London Times*, “War Games,” by Tim Wapshott.

1 June 2002 and Later Echoes of E3

3 June: CNN Money, “Your Tax Dollars at Play,” by Chris Morris.

5 June: “Penny Arcade” comic on *America’s Army*.

5 June: *The Wargamer*, Best of E3 Awards, Best First Person Tactical Shooter to *America’s Army*.

12 June: RealToons comic.

14 June: CNET, “Virtual Metal Jacket,” by Darren Gladstone.

1 July: Army Memorandum for Correspondents, “US Army Launches *America’s Army* PC Game on the Internet.”

11 July: New Digital Reporter, “E3: *America’s Army* SimSoldier,” by NDR.

11 July: *New York Times*, “Uncle Sam Wants you to Play This Game,” by Brian Kennedy.

13 July: *Stars and Stripes*, “In Army’s New Recruiting Tool, Shooting The Wrong Guys Can Send You To A Virtual Leavenworth,” by Eric B. Pilgrim.

23 July: *Monterey County Herald*, “NPS-Spawed War Games Catching on Big,” by Kevin Howe.

1 August: *Zen Gamer*, “*America’s Army: Operations* Preview,” by Marcin Manek.

5 August: *SF Chronicle*, “The Advertising Game Adopting the Latest Thing in Advertising, Army Out to Do Some Computer Recruiting,” by Carrie Kirby.

4 October: *America’s Army* appears on the new TV show “Robbery Homicide Division.”

4 Oct: Salon.com, “Weapons of Mass Distraction,” by James Au.

6 October: about.com, “Military Web3D/VR,” pp. 1, 2.

14 October: *Newsweek*, “Full Metal Joystick,” by Trent Gegax.

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